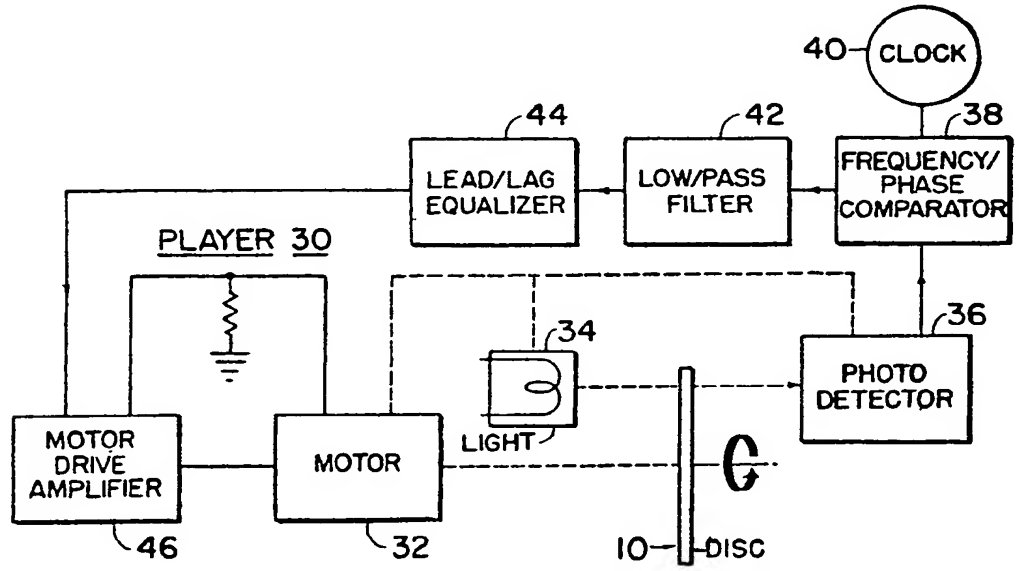
(12) UK Patent Application (19) GB (11) 2 068 151 A

(21) Application No 8100457
(22) Date of filing
8 Jan 1981
(30) Priority data
(31) 114306
(32) 25 Jan 1980
(33) United States of America (US)
(43) Application published
5 Aug 1981
(51) INT CL³ G05D 13/62
G11B 23/42
(52) Domestic classification
G3R A273 BN22
(56) Documents cited
GB 1476139
GB 1280603
(58) Field of search
G3R
(71) Applicant
Atlantic Richfield Company
ARCO Plaza
515 South Flower Street
Los Angeles
California 90071
United States of America
(72) Inventor
Kenneth A Harrison
(74) Agents
Mathys & Squire
10 Fleet Street
London
EC4Y 1AY

(54) Optical disc player timing control

(57) Apparatus for synchronizing the playing of a video record (10) includes the recording of a timing signal along with the information signal on the record and, as the record is played back, detecting the timing signal (36) and comparing it with a reference signal (40) to control the record drive (32).

FIG. 4



GB 2 068 151 A

FIG. 1

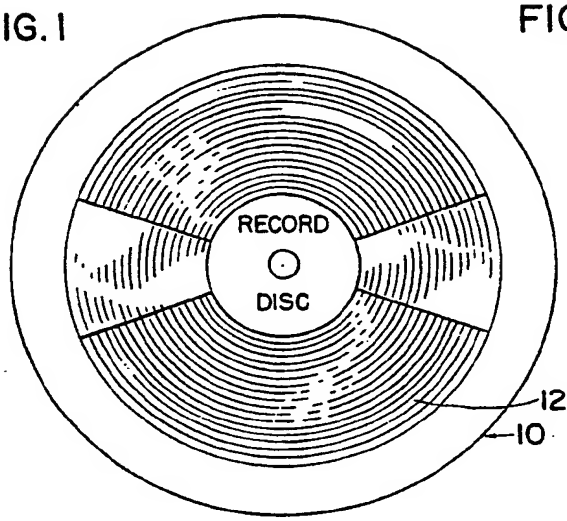
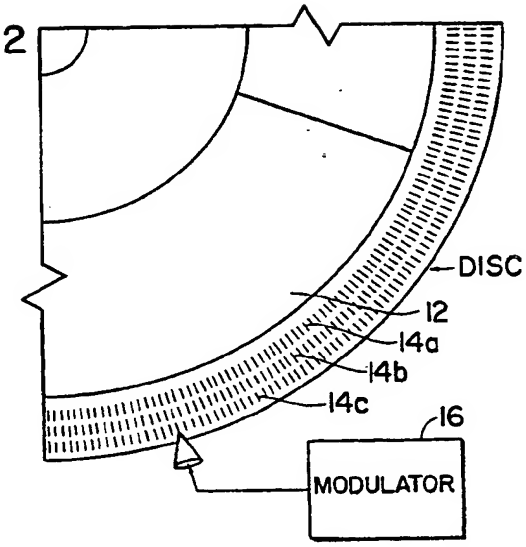


FIG. 2



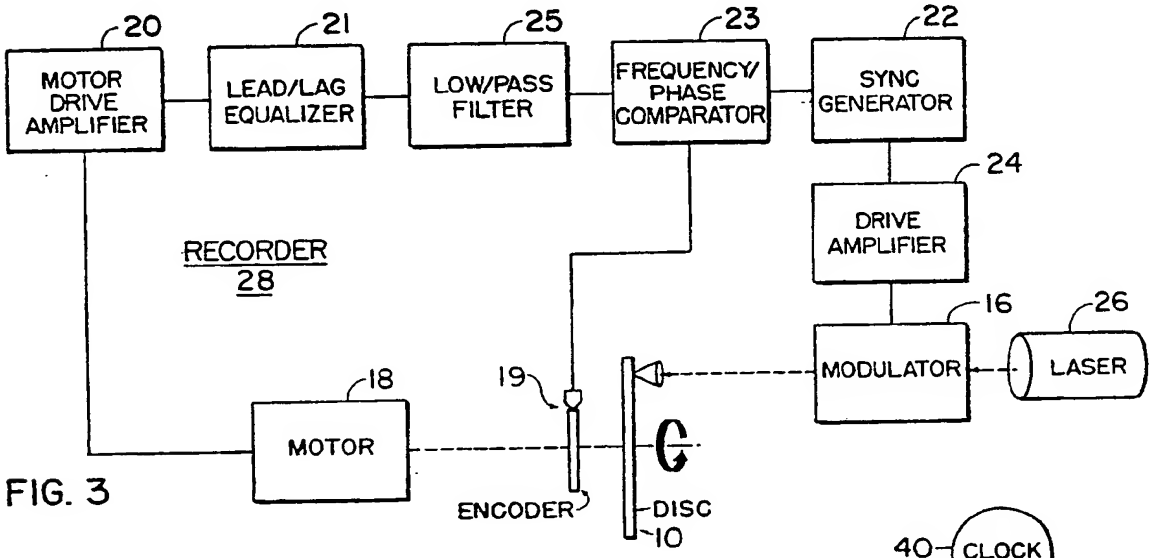
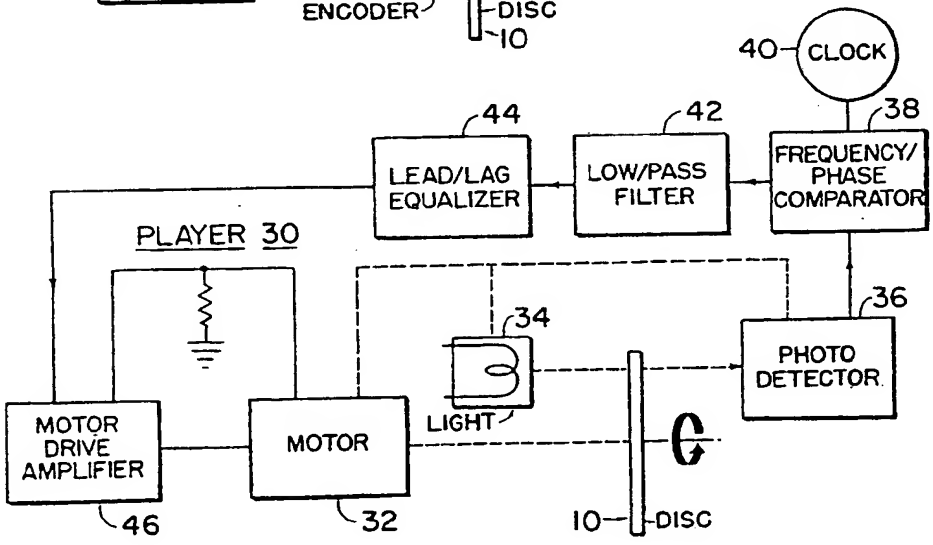


FIG. 3

FIG. 4



SPECIFICATION

Optical disc player timing control

This invention generally pertains to the storage and retrieval of information, and more particularly to apparatus, a method and a record medium for the storage and subsequent reproduction of intelligence information such as video and related audio information.

Background of the Invention

U. S. Patents which disclose prior art related to this invention are No. 3,371,154, No. 3,391,247, No. 3,446,914, No. 3,829,610, No. 3,848,095, No. 3,931,457 and No. 4,106,058. These disclosures are as examples, and are herein incorporated by reference as background to this invention. Additionally, several arts disclose the use of reference indicia of some kind of rotating objects for detection of the rotational speed of such subjects; some of these are called tachometer systems.

The speed control system and method as disclosed and claimed herein is suitable for use with any record playing system where an analog of a timing standard is recorded on a record medium and subsequently detected and utilized as part of a electrical-mechanical feedback loop for controlling the playback speed of the record medium.

Timing, as the word is used herein, means the velocity, and the change in velocity, of the recording medium past a recording element such as, for example, a modulated laser beam.

As shown in the incorporated references above identified, video disc and other record media, such as magnetic tape, have found increasing use and popularity for recording and producing intelligence signals such as video pictures with sound, for example. Generally, the picture is scanned in discrete frames on a line-by-line basis, and the audio information is concurrently recorded with both video and audio information is concurrently recorded with both video and audio analog tracks being formed on the record medium. The recorded information is transcribed from the record medium to simultaneously reproduce a picture and sound. In such system the reproduced audio and video signals are substantially coextensive in time.

A significant problem arises when playback apparatus, such as optical disc player, does not lock at the correct speed. A slight deviation in the speed at which the record is played can result in distortion of the reproduced picture. For example, a timing difference of .002% can through off the color of the reproduced picture.

Summary of the Invention

The improvement in the present invention is in the record players which are provided with means to be forced to the same sync as the recording sync by making an "encoder" or "standard" signal analog on the recording medium, such as at the outer periphery of a disc, which can then be read and speed locked or sync'd by the player servo on playback.

Differently stated, when a recording is made, the recording disc or tape may acquire a "built in" timing error somewhat analgous to the "wow" and "flutter" found in sound recordings. At the same time of recording with this invention, however, a "standard" signal of designated frequency is also recorded on the recording as a "timing" signal. When the timing signal produced from the recording is synchronized by the player with a reference standard signal produced by the player (which is the same as the standard signal used in recording), the timing of the recording when played is maintained the same as the timing when it was recorded.

As an added bonus, the encoder presently utilized in the player can be eliminated which is a cost savings.

A general object of this invention is to provide relatively simple means for precisely synchronizing the playback timing of a recording with the respective recording timing of that respective recording.

These and other objects and advantages are provided by a method of producing a video or similar signal analog on a record while simultaneously producing a timing encoder or standard signal analog on the record which standard has the characteristic of distinguishing the timing of the record as the intelligence signal analog is being produced on the record. As the recording is played to reproduce such signal, the timing standard is detected and compared with a reference standard (which is the same as the standard when recording). As necessary, the record timing is modified to provide timing signal indicia which is the same as the reference standar.

Means are provided for recording a video or similar signal analog on a record while producing a speed standard signal analog on the record which standard provides a means of distinguishing the timing of the recording while such signal is being recorded as an analog. The player means includes means for detecting such video signal and means for detecting the timing standard signal. Means are provided to produce a reference playing standard signal which is characteristic of the timing at which the player should be operating. Comparison means are provided to produce a difference signal between the timing signal and the reference playing standard signal. Controller means is provided to vary the speed of the player in response to the difference between the signals toward reducing the difference to zero. At such time as the differ-

ence signal becomes zero, the system is retained in a phase-locked loop including the player motor, the record bearing the timing standard, and indicia detection means, the comparator means and the controller means which controls the player motor speed.

Referring Now to the Drawing:

Figure 1 is a somewhat schematic plan view of a record medium in disc form having analogs of a video signal and the timing standard as provided in the present invention.

Figure 2 is an enlarged fragmentary view of the record of Fig. 1 with schematic representation of the recorded video analog and three versions of the timing standard analog of the present invention shown about the outer periphery of the record.

Figure 3 is a simplified block diagram and schematic illustration of the present invention showing only the elements involved in producing the timing standard analog and not showing the presently known elements as are used to produce the video signal analog on the record.

Figure 4 is a simplied block diagram and schematic illustration of the playback apparatus of the present invention and not showing the presently known elements as are used to reproduce the video picture and sound detected from the intelligence signal analog on the record.

Description of a Preferred Embodiment

Referring to Figs. 1 and 2, there is shown a recording medium as a disc 10 of sheet material. As shown, a recorded intelligence analog 12, such as video, extends as numerous tracks forming a band on disc 10. At the outer periphery of disc 10 are shown alternate timing standard analogs 14A, 14B and 14C. Any one of these standards may be used and, as shown in Fig. 2, a modulator means 16 is focused to produce standard analog 14C and that analog will be termed the standard analog 14 in the remainder of this description.

A preferred embodiment of video disc 10 is fabricated from a circular sheet of film having a photo-sensitive emulsion of a light transmissive substrate or base. The film is exposed as later described and developed to vary the light transmissiveness of the film in accordance with the video and standard information to be recorded thereon. One suitable film material has a fine grained silver halide emulsion on the order of six microns thickness on a 4.5 mil Mylar base. Another tough, dimensionally stable, polyester base of 7 mil thickness is an "Estar Thick Base" as provided by Eastman Kodak Company, Rochester, New York, 14650.

Though not shown, the record medium can take other forms as desired such as a cylinder having axially spaced recording tracks, or strip film or tape suitable for being transported from one reel to another. However, the photographically prepared video disc as herein described is preferred because it is inexpensive, easy to produce, and reproduce, provides a high storage density, and can be stored and transported as easily as any other developed film or photographic negatives. Also important is that the use of such a record medium permits the use of relatively inexpensive playback apparatus.

The Recorder

The method of the present invention utilizes both recording apparatus and playback apparatus. Referring to Fig. 3, the recorder system is indicated as 28. The disc 10 is rotated by a motor 18 at a speed governed by a motor drive amplifier 20 which responds to a frequency/phase comparator 23. A common frequency for sync generator 22 is 15.734 KHz. There are desirably 525 indicia per revolution of disc 10 is the standard analog 14, since there are 525 lines in the U. S. TV system under NTSC standards. A desirable speed of rotation for disc 10 is presently approximately 1800 rpm.

The pulse frequency from sync generator 22 feeds into a frequency/phase comparator 23 which compares signals from an encoder disc means 19, rotated by motor 18. Comparator 23 produces a correction signal which feeds into a lead/lag equalizer 21 which in turn actuates motor drive amplifier 20 to control motor 18. This type of disc drive system as described is commonly known in the art and need not be further described.

Sync generator 22 also feeds the pulse frequency through driver amplifier 24 and actuates modulator 16. A laser means 26 is fed through modulator 16 onto disc 10 through a lens system (not shown) and the beam from laser 26 is interrupted by modulator 16 is response to the frequency from sync generator 22 and is emitted onto disc 10 in accordance with the sync frequency.

The exposure of the pulsed laser beam on disc 10, in accordance with the pulse frequency, results in standard analog 14 as shown in Fig. 2. As previously mentioned, any of the standard analogs 14A, 14B or 14C could be produced on the disc 10. It is preferred that the analog 14C as shown be produced by modulator 16 because analog 14C is nearest to the outer periphery of disc 10 and thereby leaves additional area on disc 10 for placement of the video signal analog 12.

The Player

As stated with respect to recorder apparatus 28, the player 30 includes (not shown) the various other player components necessary to detect the video signal analog that has been produced on disc 10 to produce a video signal or signals which is a true facsimile of

the TV signal which was fed into the recorder 28.

The output of photo detector 36 feeds into a frequency phase comparator circuit 38. Also feeding into comparator 38 is a pulse from a clock circuit 40 which is of frequency the same as produced by the sync generator 22 of Fig. 3.

The comparator 38 compares the pulses from the photo detector 36 with the pulses from the clock 40 and produces a responsive output which is a binary wave form signal whose duty cycle equals the phase difference between the reference signal of clock 40 and the timing signal from photo detector 36. And, since such signals differ in phase with different timings, as is the case in this invention, then the output becomes positive or negative to accelerate, or deaccelerate, the motor 32 to the correct timing.

The output of comparator 38 feeds into a low pass filter 42 which transforms the pulses from comparator 38 into a DC signal representative of the area under the positive wave forms from the output of comparator 38. The DC output from filter 42 is fed into a lead/lag compensator or equalizer 44 which produces a positive DC signal as a control signal for the motor drive amplifier 46.

The motor 32 is current driven. The motor drive amplifier 46 is a high gain, wide band, DC coupled single-ended power amplifier with a deferential input. A current measuring resistance 48 is connected into series between motor 32 and ground. The voltage drop across measuring current resistance 48 is fed back into the motor drive amplifier 46.

Operation of the Disclosed Embodiment

In operation, the unexposed photographic disc 10 is placed into recorder 28. The signal recording apparatus (not shown) is actuated to emit the signal as a modulated laser beam system onto the disc 10 as a track. The modulator 16, in response to sync generator 22 and drive amplifier 24, modulates the laser beam from laser 26 and emits pulses of light onto disc 10 as a circular track 14 about the periphery of the disc. After the video signal 12 and the standard signal 14 has been exposed onto the disc 10, the disc is removed and developed just as photographic film is usually developed. After development, the video signal analog track appears in the area shown at 12 in Figs. 1 & 2 and the indicia signal analog 14 may show as indicated at 14C in Fig. 2, for example.

The developed disc 10 is then placed into the player 30 as shown in Fig. 4. When the player 30 is initially started, the motor 32 is not rotating at all. In this instance, the output from motor drive amplifier 46 is at a maximum to give the motor initial torque to permit maximum acceleration up toward operating speed.

As the motor 32 approaches operating speed, the light 34 actuates the photo detector 36 in response to the indicia 14 appearing on the disc. The photodetector 36 thereon produces a speed pulse signal of frequency which is proportional to the speed of disc 10 and feeds this signal into the comparator 38. The clock circuit 40 is also feeding a pulse signal into the comparator 38.

The output of comparator 38 feeding into filter 42 is a pulse signal with each pulse having a length proportional to the difference between the phase of the clock signal and the signal from detector 36 when the clock and the detector signals are of the same frequency but will stay at its maximum when the disc 10 is being rotated at less than the prescribed speed and the speed pulses are of lower frequency than the clock pulses.

The pulses from comparator 38 are smoothed into a substantially constant DC voltage by low pass filter 42 with such voltage being a function of the area under the curves of the pulse signals coming into the filter. The output then is maximum with a large difference in phase or any difference in frequency between the timing pulses of the recording and the reference clock pulses.

The lead/lag equalizer 44 receives the DC voltage from the filter 42 and in response produces a DC signal control to actuate the motor drive amplifier 46. Amplifier 46 thereon supplies a DC power current to motor 32. Thus, when the disc 10 comes up to the prescribed operating timing, for example 1800 rpm, it locks.

Though not shown, appropriate lens systems are provided in player 30 between the light 34 and the disc 10 and between the disc 10 and the photo detector 36 along with similar optical systems (all not shown) to transmit the video signal analog from the disc 10.

Description of an Alternate Embodiment

A second embodiment, or version, of the invention may be described with reference to the drawing and the foregoing description.

Referring to Fig. 2, the timing standard signal analog 14, such as shown as analog 14C, may be incorporated as part of the intelligence signal recorded as the signal analog 12. For example, the horizontal sweep sync signal incorporated with a video signal may be the timing standard signal also.

The utilization of the horizontal sweep sync signal as the timing standard signal can be particularly effective for recordings having little of the mass and inertia helpful in maintaining constant velocity during the recording operation. Also, the previously mentioned strip film, magnetic tape and the like may undergo some "stretch" during recording and/or playback which is at least part of the previously mentioned "built-in source of

error'' to which the present conventional player apparatus may be susceptible in some instances.

For this embodiment, it will be obvious to those skilled in this art that modulator 16 shown in Fig. 3 will also be an element of the intelligence signal recording circuitry. Also, in this embodiment, the photodetector means 36 shown in Fig. 4 will include means to pick out the timing standard signal from the detected intelligence signal to be compared with the clock signal 40 as previously described.

Summary

In summary, the improvement of the present invention is the means whereby the disc 10 may be rotated with precisely the same timing as the timing with which the recording was made. Consequently, if there are slight differences in the timing between different recording machines, or the recording machines of different disc manufacturers, then the player 30 will play the disc 10 at whatever timing at which it was recorded, providing of course, that the frequencies of the recorder synchronizing means (as in 22) and the player clock sync means (as in 40) are the same.

The disc 10 carries a timing standard signal which is recorded as a standard analog on the disc along with the other recorded intelligence signals. The recorded timing signal analog corresponds to the frequency of the synchronizing signal which governs the recording speed of the disc recorder. When the disc is played by player apparatus, a timing player signal is picked up from the timing standard analog and is utilized to govern the speed of the player apparatus where the recorder and later the player operate at identical timing with minimal distortion of the intelligence signal played by the player apparatus.

It is believed that this concept is universally useful in all applications where synchronized recording and playing speeds for a respective recording are a critical factor.

This invention may be seen to have important features and advantages, the most important of which is to provide a system where video pictures may be recorded and then played back without color, picture, or sound aberration as might be caused by deviated player timing.

As apparent from the foregoing, a new and improved and method for playing back intelligence signals, such as video pictures with sound, or related information, is provided. While presently only preferred embodiments have been described, it will be apparent to those familiar with the art that certain changes and modifications can be made without departing from the purview of the invention as defined by the following appended claims.

CLAIMS

1. In a method of recording and then playing back information with fidelity, the steps comprising:
   1. recording said information on a record medium as an information analog at a respective recording timing while recording a timing standard signal of designated fixed-frequency as a standard analog;
   2. detecting and reproducing said information from said information analog and a timing playing signal from said standard analog;
   3. producing a timing reference signal of said designated fixed-frequency;
   4. comparing said playing signal with said reference signal and producing a timing difference signal of magnitude corresponding to any difference between the playing timing of the record medium and said recording timing of the record medium; and
   5. adjusting, then maintaining, said playing timing of said record medium to be substantially the same as the recording timing of the record medium.

2. The method of claim 1. wherein said standard analog is recorded as a respective analog track.

3. The method of claim 1. wherein said standard analog is recorded in the same analog track along with said information analog.

4. In a method of playing back an information signal from a record medium with fidelity, which information has been recorded at a respective recording speed as an information analog while concurrently recording a timing standard signal of designated fixed-frequency as a standard analog, the steps comprising:
   1. detecting and reproducing said information signal from said information analog and producing a timing playing signal from said standard analog;
   2. producing a timing reference signal of said fixed-frequency;
   3. comparing said playing signal with said reference signal and producing a timing difference signal of magnitude corresponding to any difference between the playing signal of the record medium and the reference signal; and
   4. reducing said difference signal to zero by adjusting, then maintaining, said playing timing of the record medium to substantially the same timing as the recording timing of the record medium.

5. The method of claim 4. wherein said timing playing signal is detected from a respective standard analog track.

6. The method of claim 4. wherein said timing playing signal and said information signal is detected from the same analog track.

7. In a player for playing back information

from a record medium having an intelligence signal analog recorded thereon at a designated recording timing along with a timing signal standard analog of fixed-frequency, the combination including:

1. detection means for detecting and reproducing said intelligence signal from said intelligence analog and a playing signal from said timing standard analog;
2. signal producing means for producing a timing reference signal of said fixed-frequency;
3. comparator means for comparing said playing signal with said reference signal and producing a playing timing difference signal of magnitude corresponding to any difference between the instantaneous playing timing of said record medium and said fixed-frequency signal;
4. adjustment servo control means responsive to said difference signal for adjusting said playing timing of said player to cause said playing signal to be substantially the same as said fixed-frequency signal; and
5. said servo control means maintaining said playing timing the same as said recording timing through a locked loop feedback system including said record medium, said detection means, said comparator means and said adjustment means.

8. The player of claim 7. wherein said timing standard analog has been recorded as a separate and discrete track.

9. The player of claim 7. wherein said timing standard analog has been recorded as part of said intelligence analog.

10. The player of claim 7. wherein said information is video with picture and sound.

11. A method of recording and then playing back information with fidelity, substantially as hereinbefore described with reference to the accompanying drawings.

12. A player for playing back information from a record medium having an intelligence signal analog recorded thereon at a designated recording timing along with a timing signal standard analog of fixed-frequency, substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd —1981.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.